

Delta Smelt Logic chain – Adaptive Management example

Problem statement: Delta smelt population decreases are linked to reduced habitat availability due to the effects of multiple stressors.
Focal Stressors: Key among these stressors is reduced food availability in the places and times critical to delta smelt growth and survival.
Focal Action: Restoring freshwater tidal marsh habitat to create increased food resources to contribute to delta smelt growth and survival.

Global Goal: Recover and remove delta smelt from the state and federal list of endangered species through restoration of its abundance and distribution.
Global Objective 1 (Abundance): Recovery Index ≥ 239 for at least 2 years of any 5 consecutive year period; the midpoint of any two consecutive Recovery Index values cannot be lower than 84.
Global Objective 3 (Spatial Distribution): Collect delta smelt in all 4 zones in at least 2 years of any 5 consecutive year period in the fall midwater trawl survey; in at least 2 of the 4 zones in at least 1 of the remaining 3 years in any 5 consecutive year period; in at least 1 of the 4 zones in the remaining 2 years.

BDCP Goal ¹	BDCP Objective ²	Stressors ³	Stressor Target	Conservation Measure	Projected Outcome (s)	Metrics	Key Uncertainty ⁴	Potential Research Actions to address uncertainties	Potential Responses to Observed Outcome
Goal DTSM2 (Habitat and food): Increased quality and availability of habitat for juvenile and pre-spawning adult delta smelt in preferred habitat areas, and increase availability of good quality food for developing fish.	<ul style="list-style-type: none">Objective DTSM 2.3 (food production and export from new habitat).Individual restoration projects must show a net positive flux of calanoid copepods and mysids off of the restored wetlands into adjacent open water occupied by delta smelt. As more habitat is restored within the ROAs, the spatial distance at which net export must be detectable may be moved farther downstream from the restoration sites. (Specific details of the objective, including food production targets and export distances, are to be determined through field investigations and modeling, and refined by adaptive management.)Objective L2.10: Increase the abundance and productivity of plankton and invertebrate species that provide food production for	<p>Primary:</p> <ul style="list-style-type: none">Altered co-occurrence w prey <p>Secondary:</p> <ul style="list-style-type: none">Overbite clam	<p>Chlorophyll concentrations exceed 10 µg L-1 (Müller-Solger et al. 2002) in open water habitat used by delta smelt.</p> <p>Zooplankton concentrations [<i>to be developed</i>] in open water habitat used by delta smelt.</p>	<p>Primary (for this example): CM4 Tidal Natural Communities Restoration</p> <p><i>Other related CM's:</i></p> <p>CM 1 Water Facilities and Operation</p> <p>CM2 Yolo Bypass Fisheries Enhancements</p> <p>CM5 Seasonally Inundated Floodplain Restoration</p> <p>CM6 Channel Margin Habitat Enhancement</p> <p>CM7 Riparian Natural Community Restoration</p> <p>CM12</p>	<p>a) Tidal marsh restoration acreage target achieved</p> <p>b) Increase in nutrient concentrations)</p> <p>c) Chlorophyll concentrations exceed 10 µg L-1 (Müller-Solger et al. 2002) in open water habitat used by delta smelt.</p> <p>d) Calanoid copepods and mysid concentrations meet or exceed targets [<i>to be determined</i>].</p>	<p>a) Acres of tidal marsh habitat</p> <p>b) Nutrient (Nitrate, Ammonia/um, Phosphorous, Silica) concentrations in restoration sites and flux to delta channels</p> <p>c) Chlorophyll concentrations in restoration sites and flux to delta channels</p> <p>d) Calanoid copepods and mysid concentrations in restoration sites and flux to delta channels</p>	<p>8. How does tidal marsh restoration affect production of food for covered fish and export of this food to suitable habitat?</p> <p>9. How have hydrodynamic changes associated with tidal restoration affected organic carbon export rates?</p> <p>10. How has tidal marsh restoration affected benthic invertebrate communities?</p> <p>11. How are invasive filter feeders (Asian clams) affecting zooplankton production in</p>	<p>8. Quantify the primary and secondary production, including food suitable for covered species, exported from restored tidal marsh plain into adjacent restored subtidal aquatic habitat areas.</p> <p>9. Document the export of organic carbon produced in restored tidal marsh plain into existing Plan Area channels.</p> <p>10. Determine the extent and patterns of establishment of nonnative clams in restored subtidal aquatic habitats,</p>	

¹ Source: FISH_BGO_TABLE 2012-03-12
² Source: FISH_BGO_TABLE 2012-03-12
³ Source: Nobriga & Herbold 2008
⁴ Source: BDCP Uncertainties table – ICF/ M Greenwood updates 4/15/2012

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	covered fish species in the Delta waterways. ⁵			Methylmercury Management CM13 Invasive Aquatic Vegetation Control CM15 Predator Control			restored tidelands?	particularly in relation to physicochemical parameters. 11. Compare zooplankton production in areas restored at different points in time (or with differing densities of clams) in order to judge comparisons	
Goal DTSM1 (Abundance): Increased end of year size and size-specific fecundity, and improved survival of adult and juvenile delta smelt.	Objective DTSM1.1 (End of year size): Achieve a fall mean body length increase of at least 5 mm longer than existing conditions in December as collected in Fall Midwater Trawl (65 mm vs. 60 mm fork length) within 15 years of BDCP implementation.	<ul style="list-style-type: none">• *Water exports (entrainment)• DCC• South Delta Temporary barriers• SMSCG• Diversions• Overbite clam• Toxicity• Water transparency• Low DO• SAV• *Altered co-occurrence w prey• *Predation/ other allee effects• Disease			Achieve a fall mean body length increase of at least 5 mm longer than existing conditions in December as collected in Fall Midwater Trawl (65 mm vs. 60 mm fork length) within 15 years of BDCP implementation.	Delta smelt fall mean body length in December [Fall Midwater Trawl]			
Goal DTSM2 (Habitat and food): Increased quality and availability of habitat for juvenile and pre-spawning adult	Objective DTSM2.1 (Low salinity zone habitat): Increase the extent and distribution of low salinity zone delta smelt habitat during the fall months (above POD era conditions) to support contribution to delta smelt recovery; initial	<ul style="list-style-type: none">• Overbite clam• Toxicity• Water transparency• Low DO• SAV• *Altered co-occurrence w prey							

⁵ From BDCP Feb 2012 Draft p 3-64: Restoration of tidal natural communities will contribute toward this objective. Restored emergent wetlands are expected to increase local production of organic materials and organisms that support the aquatic food web, and tidal action is expected to transport food resources via tidal channels to fish habitat. Food resources from the Suisun Marsh ROA would be transported to Suisun Bay to benefit rearing salmonids, splittail, and delta and longfin smelt. From Cache Slough ROA resources would be transported downstream of Rio Vista into the Delta and Suisun Marsh to benefit salmonids, splittail, delta smelt, and sturgeon. From the Cosumnes/Mokelumne ROA resources would be transported into the east and central Delta to benefit fall-run Chinook salmon, steelhead, delta smelt, and splittail migrating to and from the Cosumnes and Mokelumne Rivers, and to the east and central Delta to benefit juvenile salmonids, splittail, delta smelt, and sturgeon. Restoration in the West Delta and South Delta and production of food in the western Delta and Suisun Bay by export via tidal flow.

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delta smelt in preferred habitat areas, and increase availability of good quality food for developing fish.	objective to correspond to the fall outflow RPA element in the 2008 FWS BiOp, or its successor if the prescription is changed by FWS prior to completion of the isolated conveyance; the objective to remain explicitly tied to ongoing adaptive management. Objective DTSM2.2 (new habitat): Increase the extent of suitable habitat in the Plan Area to support recovery of delta smelt. Initial habitat restoration targets to be developed during formulation of an adaptive management plan for habitat restoration.	*Predation/ other allee effects • Disease							
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Notes

Related BGO's (From BDCP Feb 2012 draft)
Landscape-Scale Goals and Objectives
Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable tochanging conditions to sustain populations of covered species and maintain or increase native biodiversity.

* **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities
CM4 Tidal Natural Communities

* **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.
CM3 Natural Communities Protection and Restoration

Objective L1.6: Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.
CM3 Natural Communities Protection and Restoration

Objective L1.7: To accommodate projected future sea level rise, within the 65,000 acres of tidal restoration include sufficient upland transitional areas adjacent to restored brackish and freshwater tidal emergent wetlands to permit the future upslope establishment of tidal emergent wetland communities; also include additional noncultivated upland to provide habitat and high-tide refugia for native wildlife.
CM3 Natural Communities Protection and Restoration CM4 Tidal Natural Communities Restoration

* **Objective L1.8:** To accommodate projected future sea level rise, provide potential tidal marsh plain habitat within the anticipated future eastward position of the low salinity zone of the estuary.
CM4 Tidal Natural Communities Restoration

Goal L2 Ecological processes and conditions that sustain and reestablish natural communities and native species.

* **Objective L2.6:** Maintain or increase life-history diversity of native fish species and a diversity of spawning and rearing conditions for native fish species over time.
CM4 Tidal Natural Communities Restoration

Objective L2.7: Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.
CM11 Natural Communities Enhancement and Management

* **Objective L2.8:** Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species.
CM4 Tidal Natural Communities Restoration

* **Objective L2.9:** Provide refuge habitat for migrating and resident covered fish species.
CM4 Tidal Natural Communities Restoration

* **Objective L2.10:** Increase the abundance and productivity of plankton and invertebrate species that provide food production for covered fish species in the Delta waterways
CM2 Yolo Bypass Fisheries Enhancements
CM4 Tidal Natural Communities Restoration

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CM5 Seasonally Inundated Floodplain Restoration
CM6 Channel Margin Habitat Enhancement
CM7 Riparian Natural Community Restoration

Objective L2.10 Rationale: Achieving this objective will enhance the production and export of phytoplankton and zooplankton from tidal channels into adjacent Delta waterways in support of the aquatic foodweb. Loss of tidal communities and riparian vegetation in the Delta has greatly reduced the input of food resources for fish into adjoining sloughs and channels and the downstream bay and estuary. Habitat restoration and effective tidal exchange (CM4 Tidal Natural Communities Restoration) is expected to enhance food production. Restoration of riparian vegetation along channel margins and in floodplains (CM6 Channel Margin Enhancement and CM5 Seasonally Inundated Floodplain Restoration) and seasonal inundation in the Yolo Bypass (CM2 Yolo Bypass Fisheries Enhancement) are expected to provide organic carbon in support of the foodweb and macroinvertebrates (e.g., insects) that provide food for covered fish species.

Natural Community Goals and Objectives

Tidal Perennial Aquatic

Goal TPANC1: Tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic foodweb processes.

Objective TPANC1.1: Within the 65,000 acres of tidal restoration, restore or create at least 10,000 acres of tidal perennial aquatic in Conservation Zones 1,2,4,5,7, and 11 that support aquatic food production and habitat for covered and other native species.

CM3 Natural Communities Protection and Restoration

Tidal Brackish Emergent Wetland

Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.

* **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11.

CM3 Natural Communities Protection and Restoration

CM4 Tidal Natural Communities Restoration

* **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them.

CM4 Tidal Natural Communities Restoration

* **Objective TBEWNC1.3:** Create topographic heterogeneity in restored tidal brackish emergent wetland to provide variation in inundation characteristics and vegetative composition.

CM4 Tidal Natural Communities Restoration

* **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

CM4 Tidal Natural Communities Restoration

Tidal Freshwater Emergent Wetland

Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.

* **Objective TFEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7.

CM4 Tidal Natural Communities Restoration CM6 Channel Margin Enhancement

* **Objective TFEWNC1.2:** Restore tidal freshwater emergent wetlands in areas that increase connectivity among protected lands.

CM4 Tidal Natural Communities Restoration

* Identified as applicable to Delta smelt BGO’s in Feb 2012 draft.